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(54) Fuel burner control system.

(57) A heating plant (11) has a fuel burner (12) operated by a fuel burner control system that utilizes a program module including a microcomputer (51), memory (52), analog-to-digital converters (54-55), and sensor monitoring arrangements (53) to track the status of analog sensors. This system insures that the sensors are not open circuited or short circuited. This system can be provided with a keyboard and display unit (15) having continuous output information on the status of temperature, pressure, and flame current.

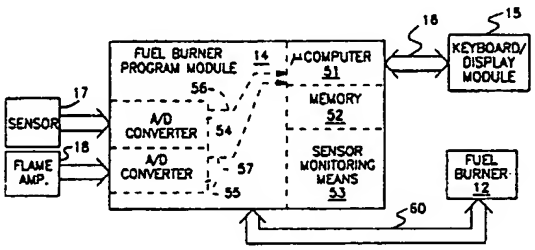


Fig. 5

EP 0 326 245 A2

FUEL BURNER CONTROL SYSTEM

BACKGROUND OF THE INVENTION

Fuel burner control systems, or systems that are commonly referred to as flame safeguard control systems, have been used for many years in non-residential type burner control applications. These devices traditionally have been devices that operate through mechanical switches and relays. Since mechanical switches and relays provide "on-off" type of control or "go" or "no-go" functions the sensors used with the systems have been compatible switching type devices. These devices have been pressure operated, temperature operated, or flame operated. The sensor function would be to either provide an open or closed circuit.

This type of sensor structure has two significant faults. First, the sensor is incapable of providing ongoing information and is limited only to providing information as to a switched or limit condition. Secondly, this type of device is susceptible of being bypassed by users and maintenance people. Maintenance people traditionally jumper or open circuit sensors while troubleshooting. This type of troubleshooting can lead to serious and often unsafe conditions. Also, the ability to either short circuit or open circuit a sensor makes a system susceptible to being operated in an unsafe condition either intentionally or inadvertently by a person unaware of the risks involved.

SUMMARY OF THE INVENTION

In recent years, microcomputer based flame safeguard or fuel burner control systems equipment have been marketed. These devices have the intelligence to be operated in a more meaningful way than their electromechanical predecessors. While this has been true, the widespread use of electromechanical and mechanical sensors and limits has carried over into the environment of computer based flame safeguard equipment.

Since computer based flame safeguard equipment is capable of responding to a range of sensed signals, it is now proposed that the sensors used with such equipment be converted to analog type sensors. These sensors would be typically variable resistance, variable voltage or variable current output devices that are responsive to pressure, temperature, or flame intensity. With an analog signal available, the more intelligent microprocessor or computer based equipment can convert the analog information into a complete range of digital signals. The digital signals can then be compared against preselected valid ranges of signals. This provides an analog sensing arrangement that has two distinct advantages.

The first distinct advantage is the ability to obtain continuous readouts of the analog value by the analog to digital converter and the use of the microcomputer based flame safeguard device with an appropriate display. Such displays are liquid crystal alphanumeric displays that would be capable of providing a complete range of readouts of various analog sensed signals in a flame safeguard or fuel burner control system.

The second advantage, and one which has a major safety implication, is the use of a preselected range of acceptable values with a microcomputer based system that has memory and a monitoring system to insure that the range is adhered to. This would discourage the short circuiting or open circuiting of a condition sensor without the fuel burner control system responding to shut down the fuel burner in a safe manner. This would discourage service personnel and others from intentionally short circuiting or open circuiting the sensors during any troubleshooting activities, or interfering with any of the sensors in an attempt to operate a system that otherwise should be repaired.

In accordance with the present invention, there is provided a fuel burner control system adapted to control a fuel burner for a heating plant which supplies a heat exchange fluid to a heating load, including: fuel burner program module means including microcomputer means, memory means, analog-to-digital converter means, and sensor monitoring means; condition sensor means responsive to operating conditions for said fuel burner and said heating plant; said condition sensor means having analog output values; preselected valid ranges for said analog output values being stored in said memory means; said analog-to-digital converter means and in turn said sensor monitoring means connected to review said condition sensor means analog output values to verify that said sensor means output values are within said preselected ranges deemed as valid; and said fuel burner program module means responding to said output values to safely operate said fuel burner and said heating plant.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram of fuel burner control system disclosed with a boiler;

FIGURES 2, 3, and 4 are disclosures of some analog type sensors;

FIGURE 5 is a block diagram of a burner control system, and,

FIGURE 6 is a flow chart of the safety checking feature.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In Figure 1 a heating plant 10 is disclosed made up of a boiler 11 and a fuel burner 12 along with the necessary fuel burner control system generally indicated at 13. The fuel burner control system 13 is made up of a fuel burner program module means 14 and a keyboard and display module means 15. The keyboard and display module 15 is connected to the fuel burner program module means 14 by a communication bus 16 that ties the heating plant 10 to other, unrelated equipment. The fuel burner control system 13 is completed by the addition of analog sensors 17 and a flame detector 18 cooperating with the fuel burner 12.

The fuel burner 12, when in operation, generates sufficient heat in or at the boiler 11 to supply hot water or steam via a pipe 20 to a heating load 21 (that does not form part of the invention). The heating load 21 returns the water or steam condensate via a pipe 22 to the boiler 11 in a conventional manner. The fuel burner program module means 14 will be discussed in more detailed in connection with Figure 5. At this point, it is sufficient to state that the fuel burner program module means 14 contains a microcomputer, memory means, analog-to-digital converter means, and a sensor monitoring means. These means combine to provide the fuel burner program module means 14 with the capability of receiving signals from the analog sensors 17 and the flame detector 18. These signals are converted from an analog format to a digital format in analog to digital converters. The information is then utilized in the microcomputer means along with the sensor monitoring means to provide two functions that have not been available in previous equipment.

In Figures 2, 3 and 4, three different types of analog sensors are disclosed. In Figure 2 a pressure responsive analog sensor 25 is provided. A housing 26 mounts a pressure responsive tube 27 to a housing 28 that is sealed by a diaphragm 30. Mounted on the diaphragm 30 is a solid state or strain gage type of sensor 31 that changes resistance with flexure of the diaphragm 30. The solid state sensor 31 has a pair of conductors 32 and 33 that can be used to connect the sensor to appropriate terminals (not shown) in the fuel burner program module means 14. A conductor 29 provides a fixed voltage to the sensor 31 and the sensor output is a variable voltage. The tube 27 is exposed to the pressure within the boiler 11 or some other similar situation for measuring water or steam pressure. The pressure is transmitted to the diaphragm 30 which is allowed to flex under changes of pressure. This flexure in turn changes the resistance of the element 31, and changes the output voltage available on conductors 32 and 33 so that an analog signal is provided to the fuel burner program module means 14.

In Figure 3 a temperature responsive analog sensor is provided. A housing 35 is provided with a threaded mounting means 36 to insert a tube 37 into the boiler 11 in a fluid tight manner. Contained within the tube 37 is a temperature responsive resistor 40 which has a pair of leads 41 and 42 which project through the housing 35. Changes in temperature in the boiler 11 are sensed by the temperature responsive resistor 40, and its resistance varies. This variance is provided as an analog sensor signal to the program module means 14.

In Figure 4 a flame detector 44 of a conventional ultraviolet type is disclosed. A pair of conductors 45 and 46 connect the sensor 44 to a flame amplifier means 47 that has an output at 50 that is a variable voltage signal in response to the magnitude of the flame sensed by the sensor 44. Once again, an analog type of output signal is available at 50 in response to a flame in the fuel burner 12.

In Figure 5 a fuel burner program module means 14 is disclosed in some detail. This fuel burner program module means 14 utilizes a microcomputer 51 that has a memory 52 and a sensor monitoring means 53. Contained within the sensor monitoring means 53 there is stored preselected valid ranges of signals from different types of analog sensors. The information stored will depend on the particular application that can be readily understood as the storing of a preselected range of resistances for a pressure sensor, a preselected range of resistances for a temperature sensor, and a preselected range of currents for the flame amplifier means. This information allows the fuel burner control module 14 is appropriately respond to the requirements for operation of the fuel burner 12 under the control of the analog sensors 17 and 18.

In Figure 5 there is further disclosed a pair of analog to digital converters 54 and 55. Analog-to-digital converter 54 is connected to the sensors 17 which could be either a pressure sensor or a temperature sensor as disclosed in Figures 2 and 3. The analog-to-digital converter 55 is connected to the flame amplifier means 47 and flame sensor 18.

The system disclosed utilizes two analog-to-digital converters as a matter of convenience. The requirements of the range of control for the output signal of the sensors 17 is normally different than the range of sensitivities or values for the output of the flame detector 18. By using two analog-to-digital converters 54 and 55 these differences can be readily handled within the fuel burner module means 14. It is noted that the analog to digital converter 54 is connected at 56 to the microcomputer 51, while the analog-to-digital converter 55 is connected at 57 to the microcomputer 51.

To complete the system, the microcomputer 51 is connected by the bus 16 to the keyboard and display module means 15, and by the bus or connection means 60 to the fuel burner 12. The keyboard and display module 15 typically would have both a keyboard for inputting information into the system, and an alphanumerical display, such as a liquid crystal display for the visual display of both input and output data. The keyboard and display module means 15 thus can continuously be provided with readings of the range of the analog signals from sensors 17 and 18, as well as other information, such as general status, annunciator information, faults and shutdown.

In Figure 6 a flow chart is provided for the novel safety function within the present disclosure. A standby routine 61 is provided that continuously reviews the status of the sensor condition via the magnitude of the signal being presented. The continuous review can be normal upper and lower boiler operating limits, as well as the normal range of limits of the sensors. The analog value obtained by the standby routine 61 then is reviewed at 62 to determine if it is greater than the minimum of the preselected ranges involved. If it is not at 63, the system goes on to show a fault and the system shuts down at 64 in a safe manner.

If the evaluation at 62 indicates that the condition is greater than an established minimum, as indicated at 65, a further decision is made at 66. The decision at 66 is whether the condition is less than a maximum allowable condition. If it is not at 67, again the system shuts down on safety at 64. If the condition is within the allowed range at 70, the loop is closed back to the standby routine 61 where it is again run.

The operation of the sensor monitoring means 53 of Figure 5 provides the continuous standby routine that review the sensor condition magnitude, and thereby insures that the system is operating without an open circuited or short circuited analog sensor. The particular limits to which the system operates are preselected for the particular installation, type of sensors used, and other conditions needed to provide the heating plant 10 with proper operation. It is apparent that the microcomputer 51 is capable of supplying all types of status information to the keyboard and display module 15 to provide status information during a normal run, as well as trouble or annunciator information in the event of a fault and shutdown.

A preferred embodiment of the present invention has been specifically disclosed and is clearly subject to modification within the knowledge of one skilled in this art. The applicants wish to be limited in the scope of their invention solely by the scope of the appended claims.

Claims

1. A fuel burner control system adapted to control a fuel burner (12) for a heating plant (11) which supplies a heat exchange fluid to a heating load (21), including: fuel burner program module means (13) including microcomputer means (51), memory means (52), analog-to-digital converter means (54, 55) and sensor monitoring means (53); condition sensor means (17, 18) responsive to operating conditions for said fuel burner and said heating plant; said condition sensor means having analog output values; preselected valid ranges for said analog output values being stored in said memory means; said analog-to-digital converter means and in turn said sensor monitoring means connected (56, 57) to review said condition sensor means analog output values to verify that said sensor means output values are within said preselected ranges deemed as valid; and said fuel burner program module means responding to said output values to safely operate said fuel burner and said heating plant.

2. A fuel burner control system as claimed in Claim 1 wherein said system (13) responds to an open circuited condition sensor means (17) as an unsafe condition.

3. A fuel burner control system as claimed in Claim 1 or 2 wherein said system responds to a short circuited condition sensor means (17) as an unsafe condition.

4. A fuel burner control system as claimed in any one of the preceeding Claims wherein said condition sensor means includes temperature responsive sensor means (40) that have a variable resistance as an output analog value.

5. A fuel burner control system as claimed in any one of the preceeding Claims wherein said condition sensor means includes pressure responsive sensor means (30) that have a variable voltage as an output analog value.

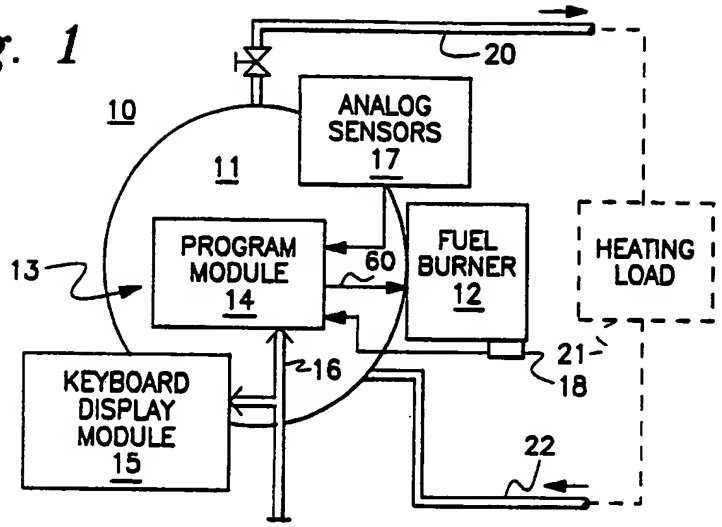
6. A fuel burner control system as claimed in any one of the preceeding Claims wherein said condition sensor means includes a flame sensor (44) and an amplifier means (47) that has a variable voltage as an output analog value.

7. A fuel burner control system as claimed in Claim 6 wherein said analog-to-digital converter means includes two analog-to-digital converters (54 & 55) with a first of said analog-to-digital converters (55) operable with said flame sensor and amplifier means (18).

8. A fuel burner control system as claimed in any one of the preceeding Claims wherein said analog-to-digital converter means includes two analog-to-digital converters with a second of said analog-to-digital converters (54) operable with said temperature responsive sensor means (40) and with said pressure responsive sensor means (25).

9. A fuel burner control system as claimed in any one of the preceeding Claims wherein said burner control system further includes a keyboard and display module means (15) with said keyboard and display module means having output display means capable of displaying said sensor means output values.

Fig. 1



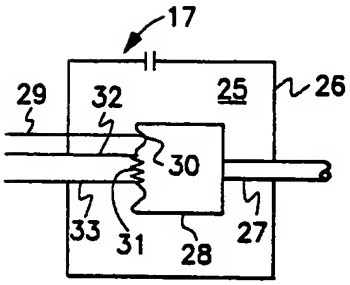


Fig. 2

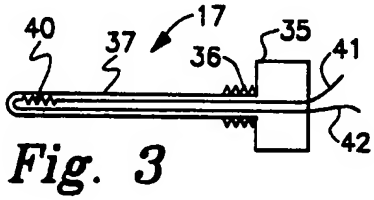


Fig. 3

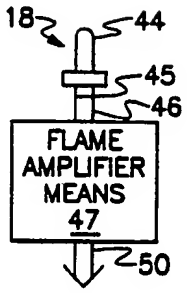


Fig. 4

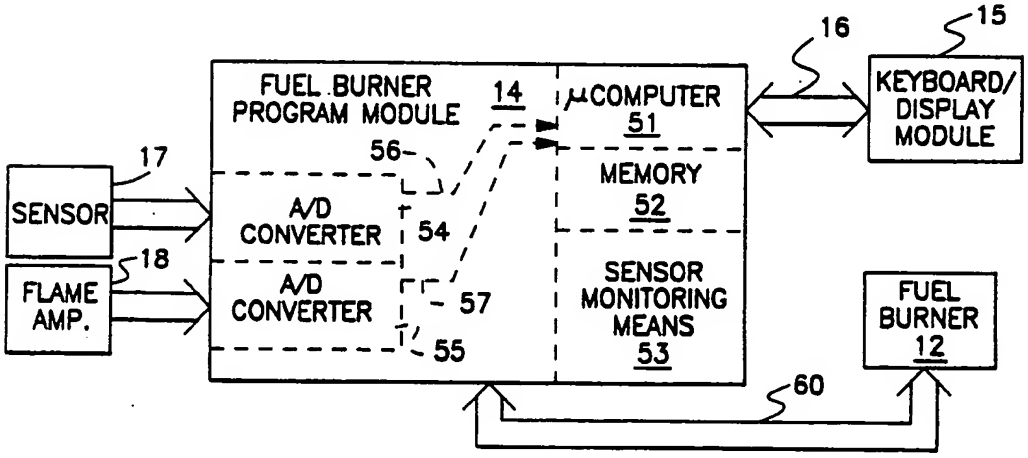


Fig. 5

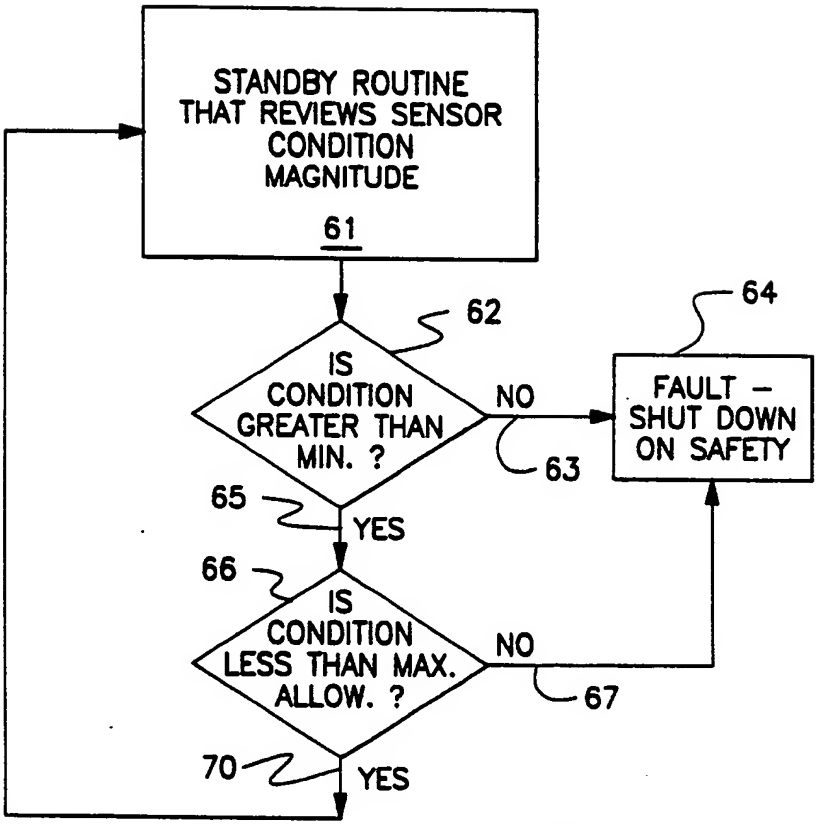

STANDBY ROUTINE THAT REVIEWS SENSOR CONDITION MAGNITUDE
61
62
IS CONDITION GREATER THAN MIN. ?
NO
63
64
FAULT – SHUT DOWN ON SAFETY
65
YES
66
IS CONDITION LESS THAN MAX. ALLOW. ?
NO
67
70
YES

Fig. 6